often interrupted by the breakage of the wire rope; for this purpose two engines are used, one at each end of the tunnel, while the obvious and ordinary arrangement would be to employ only one engine driving a shaft with two drums and an endless rope. The arrangements might be very similar to those adopted in mines for raising and lowering the "cage," except that in this case the cage would be the carriage, and would travel on nearly a level line instead of up and down a shaft. The mode adopted for raising and lowering passengers in the shafts attached to the subway is by means of a chain which draws the carriage up and down, various "safety" arrangements being adopted in case of the giving way of the chain. For raising and lowering passengers, a chain or rope is not however the best means. In the apparatus in use in all the best hotels in America, there are no chains or ropes, no catches, springs, or buffers in case of accident. There is a vertical hollow cast-iron column reaching through the whole length of the shaft; in that shaft is the thread or helix of a screw projecting a couple of inches from its surface; the cage forms part of the nut, which rests in the screw or shaft. The shaft is turned by a small engine, controlled by the guard, who travels with the cage; he can moderate, stop, or reverse the motion, and accidents in the ordinary sense are out of the question. It will thus be seen that the problems to be solved as to the best means of transporting passengers through the Tower Subway are of the simplest kind.

We understand that the late Mrs. Appold has left to the Institution of Civil Engineers, a legacy of 1,000*l.*, payable at the same time as the legacy for a similar amount from her husband, the late Mr J. G. Appold, F.R.S., Assoc. Inst. C.E. It is believed that both bequests have been made "for the general use and benefit of the Society," without being fettered with any conditions.

To those of our Scientific Societies who annually assure themselves, and others, of their continued existence by a dinner, we commend the "Report of the Speeches at the Annual Dinner of the Institution of Civil Engineers, May 4, 1870," which we have just received,—as an indication of what a little energy can make even of a dinner. Professor Tyndall answered for Science, showing in a clear way how physical research lies at the root of all conquests of Nature, gaining help in turn from the practical man. "Thus does the human intelligence oscillate between sound theory and sound practice, gaining by every contact with each an accession of strength. These two things are the soul and body of science, as far as you and I are connected with it. Sever sound theory from sound practice, and both die of atrophy. The one becomes a ghost, and the other becomes a corpse."

We have received the first and second volumes of Dr. L. Lindenschmit's "Die Alterthümer unserer heidnischen Vorzeit," from originals in public and private collections, published under the authority of the Roman-German Central-museum at Mayence. The illustrations are most copious, and the work admirably done.

Dr. R. Caspary reprints from the Transactions of the Natural History Society of Halle a paper on the genus *Nuphar*. In examining the water-lilies of the Black Forest, as well as of Prussia and other districts of Northern Europe, he finds an intermediate form between *Nuphar luteum* and *N. pumilum*, which he regards as a true natural hybrid between two distinct species, and not as a mere transitional form. Another reprint from the Transactions of the same society is an essay on the Lennoaceæ, by H. Graf zu Solms-Laubach.

Koner's *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* contains a number of most valuable geographical papers, accompanied with carefully-executed maps; and a list of all geographical works, maps, and plans in all languages published between December 1868 and November 1869.

THE PHYSICAL CONSTITUTION OF THE SUN

Dr. Gould has addressed an important letter on the above subject to the Journal of the Frankland Institute. In the first part he refers to the new light recently thrown on the sun's physical constitution by the observations of Mr. Lockyer, and agrees with him and Dr. Frankland, both as to the absorption taking place in the chromosphere and photosphere itself, and also as to the possible telluric origin of the corona.

He then proceeds with regard to the probable age of the sun:—

"The researches of Helmholtz and Thomson regarding the age of the sun as a source of cosmical heat have shown us limits within which, in the absence of more decisive evidence, we must restrict our theories as to the length of time during which he has warmed the earth. The contraction-theory has been most ably discussed by these eminent physicists, and seems to afford the only satisfactory mode of accounting for the solar light and heat, now that we know both that the meteors generally revolve in cometary orbits, and that the habitability of the earth, as well as the apparent unchanged mutual attraction of the planets, bears testimony to the incorrectness of the meteoric theory. From Pouillet's data (derived from experiments which ought to be repeated in some year when the solar spots are at a minimum) Helmholtz has shown that, even were the sun's density uniform, a contraction of $\frac{1}{10}$ per cent. in his diameter would evolve 20,000 times the present annual supply of solar heat. But when the sun was hotter the same proportional contraction would have evolved yet more heat; so that we must consider the above estimate as a minimum.

"The expansibility of hydrogen gas for 100° C. is 0·3661. No gas appears to have so small a coefficient as 0·360, which would correspond to a linear expansion of 0·108. The expansibility of glass, the smallest known, I believe, even for a solid, is about $\frac{1}{150}$ part as great; say 0·00244 in volume, or 0·00081 linear. Therefore for glass even, a contraction of 1 per cent. in diameter would imply a fall of temperature by 1230° C., and a mean specific heat of 218. This seems certainly a minimum value.

"But if we suppose the expansion coefficient to be as large as that of hydrogen, a contraction of 1 per cent. would correspond to a change of temperature by 8·2° C. or a mean specific heat of 32,700, if equivalent to 20,000 years' supply. This is out of the question.

"Now Thomson has computed that bodies smaller than the sun, falling from a state of relative rest at mutual distances which are large in comparison with their diameters, and forming a globe equal to the sun, would generate 20,000 times the present annual supply. This would be greater did we consider the unquestionable increase of the sun's density towards his centre. And since it seems out of the question that resistance and previous minor impacts could have consumed more than one-half the heat, he inferred ten million times a year's supply to be the lowest, and one hundred million times to be the highest, estimate of the sun's initial heat.

"Now we have every reason for the belief that radiation is proportional to temperature. Assuming this and taking the temperature of the sun's photosphere as 14,000° C.,

10,000,000 times the present annual supply would be radiated
in 3,650,000 years if the specific heat were 218,
in 7,280,000 ,, ,, ,, ,, 1000.
100,000,000 times the present annual supply would be radiated
in 8,250,000 years if the specific heat were 218,
in 25,500,000, ,, ,, ,, ,, 1000.
500,000,000 times the present annual supply would be radiated
in 11,700,000 years if the specific heat were 218,
in 38,900,000 ,, ,, ,, ,, 1000.

"For vapours, other than hydrogen, the greatest known specific heat, so far as I am aware, is 0·508 (ammonia); and hydrogen, which has less than 3·5, cannot form any considerable portion of the sun's mass.[*] A specific heat so high as 1,000 seems altogether out of the question; yet it will be seen that, even on this supposition, an amount of initial heat equal to 500,000,000 the present annual supply, would have been radiated in less than forty million years, were the sun's radiative capacity proportional to his temperature. Taking the more probable age, 10,000,000 years, we should find 226 million times the present annual supply to have been radiated within this period if the specific heat were not greater than 218; and even were the specific heat 1,000, the total radiation would have been eighteen million times a year's radiation at present.

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[*] It seems to form certainly not more than the 18,000th part of the mass of the earth.

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"Thus the limit given by Thomson, although so vastly below that afforded by the speculations of some geologists, would appear itself to demand a considerable additional reduction. And I cannot see how we can well suppose the sun in its present form to have radiated heat for more than twenty millions of years, while three or four millions would seem to be a far more probable estimate, unless the thermic laws be totally different in those exalted temperatures which we must suppose to have existed at some past epoch.

"The very great diversity of the limiting values for the specific heat seems to afford ample scope for every needful allowance on account of the natural action of the particles within the body of the sun, even conceding to this the immense effect (analogous to the increase of specific heat) which has been assigned to it by some investigators. Even did we conceive a primitive heat equal to 200,000,000 times the amount now yearly radiated, and a specific heat 10,000 times as great as is possessed by any known gaseous body excepting hydrogen, we could not deduce so long a period as 80,000,000 of years for the past duration of the sun's heat."

SCIENTIFIC SERIALS

THE *Geological Magazine* for May (No. 71, or Vol. vii., No. 5) commences with a biographical sketch of Mr. G. Poulett Scrope, whose investigations into the phenomena of vulcanicity certainly entitle him to a distinguished place among eminent living geologists. This article is illustrated with an admirable portrait. Mr. Jenkins communicates an article on the surface geology of Belgium, in explanation of his map, a reprint of which appeared in the April number of the magazine. Mr. Maw notices two sections on the borders of Shropshire and Cheshire, in which Rhætic beds with characteristic fossils are exposed. In a paper on the Lower Silurian rocks of Galashiels, of which only the first part, illustrated with a map, is here published, Mr. Lapworth furnishes an important contribution to the elucidation of this confused group of rocks. The article in this number which will be generally read with most interest is one by Mr. James Croll, upon the boulder clay of Caithness, which he maintains to be a product of the action of land ice. This paper also is incomplete. Professor Rupert Jones notices and figures the species of Entomostraca from the coal measures of South Wales; several of the species are described as new. Lastly, Mr. Judd's paper, on the use and application of the term Neocomian, contains a good discussion of a matter which, although it seems to be merely a question of terminology, is really, especially at the present moment, one of considerable importance to geologists. Besides the usual reviews, notices, &c., the present number contains a supplementary paper by Mr. Samuel Hyde, on deep-mining in the south-west of Ireland, which possesses much economical interest.

THE *Ibis*, a Quarterly Journal of Ornithology, New Series, No. 22, April 1870. (Van Voorst.)—This number contains:—(10) "Notes relating chiefly to the Birds of India," by Mr. Blyth—the results of an examination of the specimens in the Leyden Museum; (11) "Note on the Systematic Position of *Indicator*," by Mr. P. L. Sclater; (12) "Stray Notes on Ornithology in India," by Mr. Allan Hume; (13) "On New and Little-known Birds collected during the Voyage of the *Magenta*," by Drs. Giglioli and Salvadori; (14) "A List of the Birds of Turkey" (continued), by Capt. Elwes and Mr. T. E. Buckley; (15) "On Rare and Little-known *Limicolæ*," by Mr. J. E. Hasting, determining and discriminating two puzzling species of *Eudromias*, *E. asiaticus*, and *E. veredus*; (16) "On the *Oriolidæ* of the Ethiopian Region," by Mr. R. B. Sharpe—a very elaborate article; (17) "On the Ornithology of Hainan" (continued), by Consul Swinhoe; (18) "On existing Remains of *Alca impennis*," by Prof. Newton, showing that there remain to us of this supposed extinct bird 71 or 72 skins, 9 skeletons, detached bones of 38 or 41 individuals, and 65 eggs. (19) "Notices of Recent Ornithological Publications"—English, French, Dutch, German, Russian, and American, wherein more than twenty works are briefly reviewed; and (20) "Letters, &c.," from Messrs. Layard, Hume, Brooks, and R. Gray, Col. Tytler, Lord Walden, Mr. C. Horne, Capt. Fielden, Herr von Pelzeln, Dr. Salvadori, and Messrs. P. L. Sclater, Harvie Brown, Hawkins, H. Saunders, Elliot, Tristram, and Skeat—the last a communication which will interest others than ornithologists, for it explains the etymology of the name "Grey Lag Goose"—the goose that *lagged* behind the others bred in this country when its congeners had departed for their summer quarters. The number is illustrated by some woodcuts, and by five beautiful coloured plates, by Mr. Keulemans, representing eight species of birds, of which six have never been figured before, and the other two in imperfect plumage only.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 5.—The Bakerian Lecture, "On the Pre-Carboniferous Floras of North-Eastern America, with especial reference to that of the Erian (Devonian) Period." By J. W. Dawson, LL.D., F.R.S., &c., Principal and Vice-Chancellor of M'Gill University, Montreal.

The attention of the author was first directed to the Devonian as distinguished from the Carboniferous flora, by the discovery, on the part of Sir W. E. Logan, in 1843, of some remarkable remains of plants in the Sandstones of Gaspé, Canada. In 1859, after visiting Gaspé to study these plants *in situ*, descriptions of them, and more particularly of the two characteristic Lower Devonian genera *Prototaxites* and *Psilophyton*, were published in the Journal of the Geological Society. Subsequently additional material was obtained by personal investigation of the Devonian of Maine and New Brunswick, and through the kindness of Prof. James Hall, from that of New York. These additional plants were also published in the Journal of the Geological Society. Still more recently, a thorough re-examination of the Gaspé beds, the systematic exploration of the plant-bearing beds near St. John by Prof. Hastt, and fresh collections made by Prof. Hall, have enabled the author to prepare a catalogue of 121 species, and to attempt a thorough revision of the Erian flora, and an investigation of its conditions of growth and relations to the Carboniferous flora.

The term "Erian" is applied to the formations included between the top of the Upper Silurian and the base of the Carboniferous, on account of the uncertainties which have attended the subdivision and limitation of the Devonian of Europe, and also on account of the immense area occupied by these beds on the south and west of Lake Erie, and their admirable development with regard to subdivisions and fossils. The name "Erie Division" was also that originally applied to this typical series by the geologists of the Survey of New York.

A large part of the paper was occupied with the revision of the Erian flora, including the description of twenty-three new species, and more ample descriptions of others previously known only in fragments. Large trunks of *Prototaxites*, from the base of the Lower Devonian, were described, and full details given of the form, structures, and fructification of two species of *Psilophyton*. The new genus *Ormoxylon* was described. The genus *Cyclostigma* was noticed, as represented by two species in America, and its foliage and fruit described for the first time. The genera of the Erian Ferns were examined and corrected, and several interesting trunks and stipes belonging to Tree-ferns were described. The fruits of the genus *Cardiocarpum* were illustrated with reference to their structure. The occurrence of *Lepidophloios*, *Calamodendron*, and other forms in the Middle Devonian was noticed for the first time.

The third part of the memoir was occupied with comparisons and general conclusions. At the close of the Upper Silurian period there was a great subsidence of the land in Eastern America, proved by the wide extent of the marine beds of the Lower Helderberg (Ludlow) group. It was on the small areas of Lower Silurian and Laurentian land, remaining after this subsidence, that the oldest land plants known in the region flourished. Re-elevation occurred early in the Devonian period, and the known flora receives considerable extension in the shallow-water beds of the Lower Erian. The subsidence indicated by the great Carboniferous limestone interrupted these conditions on the west side of the Appalachians, but not on their eastern side. At the close of this we find the rich Middle Devonian flora, which diminishes toward the close of the period; and after the physical disturbances which on the east side of the Appalachians terminated the Erian age, it is followed by the meagre and quite dissimilar flora of the Lower Carboniferous; and this, after the subsidence indicated by the Carboniferous limestone, is followed by the Coal-formation flora.

If we compare the Erian and Carboniferous floras, we find that the leading genera of the latter are represented in the

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